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Indian Standard

कंडेनसेट पॉलिशिंग (पावर प्लांट) के लिए मार्गदर्शिका

(पहला पुनरीक्षण)

Guide for Condensate Polishing (Power Plant)

(*First Revision*)

ICS 13.060.25

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Water Quality for Industrial Purposes Sectional Committee, CHD 13

FOREWORD

‘This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Water Quality for Industrial Purposes Sectional Committee had been approved by the Chemical Division Council’.

In the power industry, both nuclear and thermal, concentration of impurities coming in from condenser tube leaks in certain localized areas of steam generators/boilers could be of several orders of magnitude higher than that indicated by routine bulk boiler water analysis. As boiler operating pressures and steaming rates have continually increased, this localized impurity concentration effect has become increasingly predominant. Surveys conducted on the operating experiences of high pressure boilers/steam generators all over the world have indicated that in addition to engineering and metallurgical choices like design, appropriate selection of constructional materials and fabrication techniques as well as good operational practices, an efficient boiler water chemistry control played a very major role in ensuring boiler tube integrity. It is now well recognized that an efficient boiler water and steam chemistry control should necessarily start at boiler feed water stage itself. With the present day knowledge and understanding of the complex nature of local concentration mechanisms occurring in power station boilers, particularly in nuclear steam generators, and the attendant specific corrosion problems, namely, general wastage and gouging, pitting, denting corrosion, crevice corrosion, transgranular and intergranular corrosion, etc, use of high purity feed water (Na < 2 ppb; chloride < 2 ppb; sulphate < 2 ppb; specific conductivity < 0.1 µs/ cm; silica as SiO_2 < 10 ppb), with all volatile treatment (AVT) for alkalinity and dissolved oxygen control, is currently recommended for maintaining proper boiler water and steam chemistry regime.

Recently some of the turbine manufacturers are also specifying steam quality (SiO_2 < 10 ppb; Na < 3 ppb; chloride< 5 ppb; cationic conductivity < 0.2 µs/cm) to avoid stress corrosion cracking in certain high strength steels used in modern compact high rating turbines. To meet the above-mentioned feed water and steam quality specifications it becomes essential to opt for full flow condensate polishing. Thus, incorporation of a full flow condensate polishing plant (CPP) is today considered advisable for plants using sea water for condenser cooling and even for those where condenser cooling water has salinity more than 2 000 ppm. In those cases where the cooling water is of less than 2 000 ppm salinity, it is now considered worthwhile to review the requirement of a CPP. Although the concept of full flow condensate polishing emerged with boiling water nuclear power reactors (BWRs), it is now being increasingly employed for pressurized water and pressurized heavy water nuclear power reactors (PWRs and PHWRs), fast breeder reactors and large modern thermal power plants using once-through or high pressure boilers. For once-through boilers in particular, full flow condensate polishing becomes inevitable as there exists no drum for accumulation and consequent blow down of harmful impurities.

This standard was first published in 1987. In this first revision the following changes have been incorporated:

a) Amendments issued have been incorporated;
b) Online monitoring for CPU monitoring has been incorporated;
c) Condensate polishing units (CPU) chemical parameters have been incorporated;
d) References, ICS No. have been updated; and
e) Other editorial changes have been done to bring the standard in the latest style and format of Indian Standards.

The composition of committee responsible for the formulation of this standard is listed in Annex A.

Indian Standard

GUIDE FOR CONDENSATE POLISHING (POWER PLANT)

(First Revision)

1 SCOPE

This guide prescribes objectives, performance criteria and possible methods of condensate polishing for boilers for power plants.

2 OBJECTIVES

2.1 Condensate polishing plants have two following basic functions:

a) To cope with the ionic and non-ionic or dissolved and suspended impurities entering into the steam condensate due to ingress of impure cooling water through condenser tube leakages; and

b) To remove impurities generated by corrosion or erosion of constructional materials. These corrosion products could be both soluble and insoluble.

2.2 The performance criteria of such plants are that they should provide the required quality and quantity of water and be able to cope with changing operational conditions, for example, from commissioning to base load, to allow continuous operation with minor condenser leak, and to provide time for safe shut-down in an emergency, such as a large ingress of cooling water. With drum-type boilers, the inclusion of CPP reduces the frequency of chemical cleaning of the boiler and cycle heat rates can be improved as a result of reduced blow down.

3 CONDENSATE POLISHING SYSTEMS

3.1 The soluble contaminants can be removed by demineralization and insoluble by filtration. Conventional sand filters have been found to be inadequate for removal of corrosion products in the particle sizes encountered in the steam condensate and for the high flow rates they also occupy too much space. On the other hand, pressure pre-coat candle type of filters (using inert cellulose fibrous material, for example, alpha cellulose material for pre-coat) have very good removal efficiencies for 5 µm size particles and in addition, occupy much lesser space. However, the system has been almost abandoned due to uneven precoating, resulting in unsatisfactory removal of crud, sloughage from the pre-coat filter causing fouling of the anion resin and heavy capital cost.

3.2 The dual purpose of filtration and demineralization can be achieved by the 'powdex process' by using finely ground cation and anion resins (about 25 µm size) as the pre-coat material along with alpha cellulose. The pre-coat normally consists of 0.5 kg/m^2 each of cation and anion resins and 0.2 kg/m^2 of the fibrous inert material (like alpha cellulose) and has a retention capacity of about 65 g $iron/m^2$. One clear advantage of the finely ground resin is its capacity to withstand higher temperatures and its better efficiency for the removal of colloidal, hydrated iron oxide. This make it possible to install finely ground resin filter just upstream of the deaerator, thus helping in the removal of crud picked up from the tube side of the low-pressure heaters. However, these filters/ demineralizers are non-regenerable type and the resins have to be discarded after exhaustion. Hence, the operating costs of these units are about 10 times higher than that of deep bed demineralizers. In addition, these are not able to fully cope with the ionic impurities coming in from condenser tube leakages, and this is particularly true for sea water cooled plants.

3.3 Experience has shown that deep (about 1 m bed depth) mixed bed demineralizer units provide optimum cost benefit ratio while realizing adequate protection against ionic impurity ingresses into the team condensate from condenser tube leaks. However, with these units, crud removal efficiency is relatively low, and their use requires proper design and establishment of correct operating practices for smooth functioning and minimizing/avoiding resin fouling by crud. In addition, reliability of process instrumentation (conductivity meters, flow integrators, differential pressure indicators, etc) is an essential requirement.

3.4 A comparative account of the advantages/disadvantages of powdex system vis-a-vis deep bed system is given as specified in Table 1.

Table 1 Comparative Account of the Advantages/Disadvantages of Powdex System Vis-A-Vis Deep Bed System

(*Clause* 3.4)

Sl No. (1)	Powdex System (2)	Deep Bed System (3)
i)	Removes crud, and colloidal particle efficiently because of large surface area.	Not so efficient in removal of crud.
ii)	Unit is ready in a short time (back washing and pre-coating) and not very elaborate equipment is required for this.	Takes longer time for regeneration and a complete regeneration system is required. The system has to be located outside of turbine building to avoid damage to other equipment in turbine building by regenerant chemicals, fumes, etc.
iii)	Waste effluents are harmless and small in quantity.	Unspent and exchanged chemicals go as waste effluents during regeneration and their quantity is also large.
iv)	Since always fresh resin coat is used, so resin is in highly regenerated state every time resin is replaced.	Regeneration efficiency is limited due to incomplete separation of cation and anion components.
v)	Influent water temperature can be high (up to 80 °C).	Temperature restriction is 60 °C.
vi)	Resins cannot be regenerated and are to be discarded.	Resins are regenerated and indigenously available.
vii)	Resin shelf life is very short (about 6 months) and filter cartridge life also is limited (about 1 year).	Shelf life is around 5 yr if properly maintained.
viii)	Pre-coat requires vacuum holding pump, which if gets interrupted due to power supply failure, gets disturbed.	No such problem here.
ix)	Cation/anion resins ratio has to be varied with respect to types and concentration of impurities and plant conditions (ratio to be different at start-up, normal service time, during condenser tube leakage, etc).	No such problem here.
x)	Silica removal efficiency is low.	Silica removal efficiency is high.
xi)	Operating capacity is limited.	Operating capacity is large.

3.5 In addition to the above two methods, namely powdex process and deep bed demineralization, combinations of these two and other methods are also employed. These methods are as follows:

a) Pre-coat cellulose filter + strong acid cation unit + mixed bed unit;

b) Strong acid cation unit + mixed bed unit;

c) Pressure pre-coat filter using powdex + mixed bed unit;

d) Magnetic and/or deep graphite bed filters/mixed bed units;

e) Cation layered mixed bed;

f) Activated carbon filter + strong acid cation unit + mixed bed unit; and

g) Hollow fibre filter in conjunction with a deep mixed bed demineralizer.

4 CPU CHEMICAL PARAMETERS

4.1 Chemical control specifications regarding typical condensate polishing plant effluent for power plant are specified in Table 2.

Table 2 Chemical Control Specifications Regarding Typical Condensate Polishing Plant Effluent for Power plant

(*Clause* 4.1)

Sl No. (1)	Parameter (2)	Hydrogen Cycle Operation (3)	Ammonia Cycle Operation (4)
i)	Cation conductivity after removal of ammonia/amine (µs/cm at 25 °C), *Max*	0.1	0.1
ii)	Sodium, ppb, *Max*	2	2
iii)	Chloride, ppb, *Max*	1	2
iv)	Silica (as SiO_2), ppb, *Max*	10	10
v)	Soluble iron (as Fe), ppb, *Max*	5	5
vi)	Crud, ppb, *Max*	10	10

4.2 CPU Service Cycle Termination:

4.2.1 For drum type units

4.2.1.1 CPU vessel should be cut off from service if any one of the following changes is observed:

a) In-service CPU effluent specific conductivity > 2.0 µS/cm (preferably online value);

b) In-service CPU effluent cation conductivity > 0.10 µS/cm (preferably online value);

c) In-service CPU effluent sodium > 2ppb (preferably online value);

d) In-service CPU effluent chloride > 2ppb (offline value);

e) DP across the in-service CPU vessel (including DP of resin trap) > 3.5 kg/cm^2 or as specified by original equipment manufacturer (OEM);

f) In-service CPU throughput reaches to its design capacity; and

g) Boiler water chloride continuously increasing and maintained above recommended limit and there is requirement of frequent CBD opening.

4.2.1.2 Under extreme emergency condition, if fresh mixed resins bed is not available and except **4.2.1.1** (a) as above (that is, CPU outlet specific conductivity > 2.0 µS/cm), all other parameters are within limit, then that CPU may be re-taken in service after in-situ remixing of resin bed followed by thorough demineralization (DM) water rinse to get rinse water turbidity < 1 no of transfer units (NTU). However, re-mixing and service of already in-service CPU should not be adopted as regular practice.

4.2.1.3 After service, CPU effluent water quality to be kept under observation for any deviation (as specified above) and in case of deviation the particular CPU should be cut-off from service and should be considered as exhausted.

4.2.2 For drum-less units (once through unit)

4.2.2.1 CPU should be cut off from service if anyone of the following changes observed:

a) In-service CPU effluent specific conductivity > 0.10 µS/cm (online value), when unit is operating in OT feed water regime or > 0.50 µS/cm (online value), when unit is operating in AVT-O feed water regime;

b) In-service CPU effluent cation conductivity > 0.10 µS/cm (preferably online value);

c) In-service CPU effluent sodium > 2 ppb (preferably online value);

d) In-service CPU effluent chloride > 2 ppb (offline);

e) DP across the in-service CPU vessel (including DP of resin trap) > 3.5 kg/cm^2 or as specified by OEM; and

f) In-service CPU throughput reaches to its design capacity.

4.2.2.2 If any one of the above changes observed in an in-service CPU, then that particular CPU should be declared exhausted and replaced with fresh mixed resins bed. Remixing of resin bed of already in-service CPU is not recommended for once-through units.

4.3 Recommended CPU Flow for Sea Water Cooled Units

For sea water cooled units, both CPU should be kept in service during start-up and during normal operation of unit and 100 percent condensate flow through CPU should always be ensured except CPU changeover period. CPU Cut-off parameters are same as indicated above.

5 CONDITIONING METHODS

5.1 Chemical Conditioning and Condensate Polishing Plant Operation/Performance

5.1.1 The feed water chemical conditioning regime has a considerable influence on CPP Operation/performance. In utilities using AVT, hydrazine or morpholine exchange by cation resins can hamper polishing function. As very scanty information is available in the literature regarding the effect of hydrazonium ($N_2H_5^+$) and morpholinium ion on cation exchange resin performance, subsequent discussion is restricted to the effect of ammonium ion alone.

5.1.2 Originally low ammonia levels [0.2 ppm to 0.5 ppm (as NH_3); *p*H 8.8 to 9.2] were specified in the condensate, but to take account of world wide experience of erosion/corrosion, various utilities have considered the possibility of operating at higher *p*H (9.2 to 9.6) provided the system is free of copper bearing alloys in the feed train.

5.1.3 The adoption of high pH conditioning would impose an additional load of ammonium ion on a CPP operating in the hydrogen/hydroxide form. There would be approximately a three-fold increase in the concentration of ammonium ions to be removed by raising the *p*H from (9.0 to 9.2) or a seven-fold increase if the *p*H were increased to 9.6. The following are four main approaches for treating condensate:

a) Operation could continue with the cation resin in the hydrogen form thus greatly increasing the number of regenerations. Ammonia dosing has to be ensured in auto mode so that *p*H of condensate is maintained in the range of 8.8 to 9.0 in hydrogen cycle mode of operation;
b) The system could operate with the cation resin in the ammonium form, so that ammonium ion would no longer be removed, and the service period would then be dictated by pressure drop, conductivity, silica slip, etc;
c) The initial operation has the cation resin in hydrogen form and after ammonia break-through, the cycle is continued in ammonium form; and
d) To operate with the CPP on stand-by until condenser leaks occur.

5.2 Hydrogen Cycle Operation

5.2.1 Two factors control the ability of a CPP (hydrogen form cation operation) to operate satisfactorily with increased ammonia loadings. These are as follows:

a) The running period that is, possible before exhaustion of the bed; and
b) The time required to regenerate the bed. As on a regular basis regeneration of one bed takes substantially long time, any changes that could be made to offset the decreased service run lengths due to higher ammonia content in the condensate would be beneficial.

Increasing the regeneration level of the acid used for the cation resin has been considered as one possibility.

5.2.2 For the CPP with cation resin units preceding the mixed bed, it has been found that by applying an increased regeneration level (200 kg/m^3) sulphuric acid, an increased service run length could be achieved while treating condensate containing 2.2 ppm ammonia (*p*H 9.6), provided the inflow water characteristics are the same. Hydrochloric acid is also used widely for regeneration. On the other hand, for the CPP with finely ground resin unit and mixed bed, there is a much less inventory of cation resin and this restricts the ability of the plant for treating condensate of higher ammonia levels. Applying the concept of increasing the capacity of cation resins by employing higher regeneration levels, it should be possible to treat condensate containing 1.1 ppm ammonia (*p*H 9.4). Thus, under hydrogen cycle operation, increasing the level of cation resin regenerant chemical could provide a viable option for operating CPP at higher *p*H levels in condensate. However, it is essential to emphasize for the design provision for adequate cation removal capabilities to cope with flexibility of operation with respect to the conditioning of feed water with ammonia.

5.3 Ammonia Cycle Operation

5.3.1 Another chemical option for operating CPP treating condensate at *p*H 9.6 would be to use the cation resin in ammonium form. In the absence of condenser leaks very long service lengths would be possible and the regeneration will then be dictated by differential pressure across the bed due to accumulation of filtered crud. However, one has to consider two important points, namely, (a) production of water of required quality, and (b) ability of such a system to cope with cooling sea water ingress from condenser leaks. It should be noted that there is very little experience anywhere in the world on the use of ammonium form resins with sea water cooled power stations. However, it is known that use of cation resins in ammoniated form to reduce ammonia consumption results in higher sodium leakage during condenser tube leakage periods. Also, there is a general agreement in the literature that in this mode of operation the resins will have to be in a very high state of regeneration. It has been estimated that less than 0.08 percent of cation sites can be in the sodium form and less than 1.9 percent of anion sites in the chloride form in order to achieve a condensate containing less than 1 ppb sodium and 2 ppb chloride at pH 9.6. Comparative figures for hydrogen cycle operation are quite large for cation and anion resins.

5.3.2 These figures clearly indicate that extremely good separation of resins prior to regeneration and very effective regeneration techniques are essential for operation in the ammonium form, if stringent conditions for high purity feed water are to be maintained.

5.3.3 With proper separation of cation and anion resin and sufficient (approx. 200 percent) regeneration with pure regenerants (Cl less than 150 ppm in NaOH), the CPP effluent water quality mentioned in **4.1** may be easily achieved.

5.4 Operation with CPP By-passed

A third approach for operating under a high *p*H regime would be to by-pass the CPP until condenser leakage occurs. In the absence of the CPP unit there would be no extra dosing of chemicals and the bed would be maintained in a highly regenerated state. However, in this mode of operation, the disadvantage is the difficulty in deciding when to reinstate CPP, particularly if cooling water leakage is at a very low level. There is also a need to have a satisfactory working mechanism to ensure that the plant goes into service immediately when it is required.

6 DESIGN CONSIDERATIONS

6.1 Flow Rates

6.1.1 Condensate polishing involves processing of quite high flow rates. To optimize on resin and equipment cost and to reduce space requirement, it is necessary to have high flow rate demineralizers. Mechanical design, resin attrition loss, acceptable impurities, leakage past demineralizer and pressure drop considerations have led to the acceptable process flow rates of 120 m/h velocity and resin bed depth of about 1 m.

6.1.2 In CPP, where mixed bed is utilized for filtration as well as ion exchanger, provision has to be kept by incorporating a recirculation pump to see that flow rates do not drop below 60 m/h to provide an optimum filtration efficiency during start up conditions. Flow rates below this value will result in poor filtration efficiency.

6.1.3 Non-steady flow rates can introduce ionic impurity leakages in the effluent due to disturbance of the kinetic equilibrium of the bed.

6.2 Resin Type Selection and Ratio

6.2.1 High flow rate deep bed demineralization imparts certain limitations on physical characteristics of the ion exchange resin use. Particle size and grading are important from the point of view of reducing pressure drops. In addition, higher attrition strength is required. Particle size and grading are normally specified and require careful selection. The beads should be perfectly spherical without any surface cracks (when viewed under magnifying glass) and there should be no organic color throw after initial regeneration. 'Slide-test' or 'Chattillion test' are normally followed for checking the bead strength. By field experience it has been observed that on an average if the resin beads require 350 g or more to deform or break, attrition strength of the resin can be considered satisfactory (no more than 5 percent of the tested water swollen beads should require below 200 g for deforming or breaking).

6.2.2 Normally resins used for condensate polishing are strongly acidic cation and strongly basic anion polystyrene - divinyl benzene type with 8 percent to 10 percent cross linking. The choice of the resin to be used is between macroporous and gel type. The former has frequently been chosen on the basis of their greater physical strength and for their capacity to take care of any organic fouling, if expected in the power plant condensate. However, conventional gel type of resins have advantage of (a) their higher operating capacity (macroporous resins generally have 10 percent to 20 percent less operating capacity for cation resins and about 30 percent less operating capacity for anion resins), (b) better kinetic performance, and (c) being less affected by cross contamination of regenerants. Investigations are still in progress all over the world to determine the 'best' resins for particular conditions in condensate polishing plants.

6.2.3 Resin ratio is to be decided on the basis of whether the plant is to be primarily used for crud removal or for protection under condenser leakages.

Depending upon the specific use situation and the amounts of chemicals (hydrazine and ammonia or cyclohexylamine or morpholine) being added to the feed water, the cation to anion resin ratio could vary from 2 : 1 by volume (capacity ratio 3 : 1) to 2 : 3 by volume (capacity ratio 1 : 1).

6.3 Regeneration System

6.3.1 The aim of the regeneration system is to both remove particulate matter and chemically regenerate the resin beds. The process can be time consuming especially if significant amounts of particulate CRUD have to be removed. In earlier years, regeneration of a mixed bed polisher was carried out in situ. However, nowadays, it has become a rule rather than an exception to carry out the regeneration externally. Complete resin transfer from service vessel to regeneration vessel and vice versa to be ensured. External regeneration not only reduces the total outage time required for regeneration but has the greatest advantage of completely eliminating the danger of regenerants entering the system and also helps in achieving more thorough cleanup of the resins. The cleaning of the resins can be carried out by one of the following methods:

a) Back Washing — Prior to and after acid or caustic injection. Back washing flow rates are such that bed expansion is 100 percent and whole beads are not lost. During this process fine/broken beads are also eliminated;

b) Air Scrubbing/Rinsing Operation — Air scrubbing of resins is done in the tank with water up to resin top surface (for one minute), vessel pressurized with air (0.4 kg/cm^2 to 0.5 kg/cm^2) and down flow rinse given by releasing pressure through rinse outlet for two minutes. This cyclic operation is repeated a number of times; and

c) Ultrasonic Cleaning — Ultrasonic cleaning devices have now been developed to clean the resins by ultrasonic transducers mounted outside a cleaning tank. The resin slurry is introduced from top of the tank with reverse water flow from bottom to top to carry away loosened crud and resin fines.

6.3.2 When a CPP is operating with high impurity burden, it is the regeneration time that ultimately governs the availability of the CPP. Therefore, a complete regeneration system plus storage for a regenerated spare charge of resin should be considered for each individual CPP. The leakage of trace impurities from CPP is a function of the regeneration procedure, particularly the degree of contamination of mixed bed resins by the wrong regenerant and the methods to minimize such contamination are quite important. The pertinent factors are:

a) Sodium removal from all the cation resin has to be of a very high degree. This calls for complete transfer of all resin charges and better resin separation;

b) Anion resin contamination of cation resin must be avoided in order that the sulphate leakage immediately after regeneration is prevented;

c) The chosen regeneration levels must achieve the correct degree of conversion of both cation and anion resins; and

d) The rinse procedures must he satisfactory.

6.3.3 In the past the usual design philosophy has been to accept some anion resin in cation in order to minimize cation resin contamination of anion. The commonly used technique of sluicing anion resin after separation into a separate vessel, usually causes sufficient turbulence to lift some anion resin into the rise space; this resin then settles down on top of the cation resin at the end of the anion resin transfer period.

6.3.4 The desire to avoid anion contamination of cation resin has led to the concept of hydraulic separation of the two resins followed by hydraulic removal of the cation resin from beneath the anion. This development was aided considerably by the introduction of an inert bead form resin of intermediate particle size and density between the cation and anion resins. This introduction required special grading of the ion exchange resins, in which the fine beads of cation resin and the large beads of anion resin have been removed in order that three distinct sharply divided layers are obtained on backwash. Generally, now, use of inert resin is not recommended especially during initial stages (plant commissioning stage) because inert resin gets affected by the coating given on turbine blades, etc for preservation during its erection, etc. The coating makes the inert resin lighter than anion resin so that during mixed bed back-wash for separation, inert resin comes on top of the anion resin.

6.3.5 Cross contamination of resin to be tested after every five regenerations. Screen testing of resin to be tested after every ten regenerations. Chloride content in caustic used for anion regeneration should be compatible with rayon grade and preferably analytical grade (A.R.) grade ammonia to be used for boosting *p*H in condensate in hydrogen cycle. Both cation and anion resin quantities are to be made up to the design quantities so as to maintain their interface level in resin separation unit.

7 OPERATING GUIDELINES AND ANALYTICAL INSTRUMENTATION

7.1 An effluent conductivity of 0.07 µs/cm means a total maximum leakage of about 7 ppb of soluble sodium chloride, sulphate and metals, etc. Ability of condensate polishing units to maintain this level of effluent quality under normal and abnormal (during condenser leakage) conditions for sufficient length of time depends on (i) cleanliness of resins, (ii) extent of condenser tube leak, and (iii) residual ion exchange capacity of the resins at the time of leak.

7.2 It is thus necessary to have established guidelines to help the operator at the right judgement under various conditions of condensate polisher bed and condenser tube leaks. Cleanliness of the bed is ascertained by differential pressure (dP) measurements across the bed. For a specific design and resins used the 'dp' depends on the flow rate through the demineralizers and resin cleanliness. Hence, the relationship between 'dP' and flow rates has to be established. When the 'dP' approaches dirty limits, the bed is to be transferred to the regeneration facility, cleaned by air scrubbing/rinsing operation and brought back for rinse.

7.3 CPU Service vessel- fresh bed and dirty bed dP normal value is ≤ 2.1 kg/cm^2 and ≤ 3.5 kg/cm^2 respectively.

7.4 Provision of online sodium and chloride analyzers and provision of air mixing in service vessel to be envisaged.

7.5 The high quality of feed and steam generator water cannot be achieved without adequate online instrumentation and back up laboratory analysis techniques and schedules. Online analyzers for sodium (using glass membrane electrodes and buffering techniques) with detection limit of 1 ppb have been developed and methods up to 0.1 ppb are likely to be developed. Similar work is going on for development of chloride ion selective electrodes. Online silica analyzers with detection limit up to 10 ppb are already available. It is felt that with proper sampling and calibration procedures, reliance can be put on the online conductivity meters with online sodium analyzers and *p*H meters serving a secondary function. These online instruments should be used to indicate trends and do alarm functions while exact control should be by proper plant design backed-up by precise laboratory measurement methods and good analysis schedules. CO_2 content measurement in condensate come in handy to ascertain the ionic load on resin.

7.6 In addition, it would be advantageous to have an ion chromatographic system available for trace level analysis of important chemical control parameters namely, Chloride, Sodium and Silica.

8 ONLINE INSTRUMENTATIONS FOR CPU MONITORING

8.1 For monitoring of CPU parameters, following online instruments should be available:

a) Specific conductivity meter at outlet of each service vessel and common outlet;
b) Cation conductivity meter at outlet of each service vessel and common outlet;
c) Sequencer based sodium analyzer, common for one unit for measurement of sodium at outlet of each CPU;
d) DP (Differential pressure) transmitter across each service vessel;
e) DP transmitter for resin trap of each service vessel; and
f) CPU flow transmitter with integrator and reset facility for each service vessel.

9 MONITORING OF CPU RESINS DURING SHUT-DOWN PERIOD

9.1 In an idle condition/shut-down period, each CPU service vessel must be rinsed once in a week with minimum two to three resin bed volume of water. Air mixing/scrubbing and rinsing of each CPU service vessel should also be done on fortnightly basis. After rinsing, vessel should be kept in pressurized condition by using DM water pump.

9.2 If any CPU has experienced Unit startup, that CPU should be declared exhausted if Unit startup is delayed.

10 ADVANTAGES AND LIMITATIONS OF CONDENSATE POLISHING SYSTEM

10.1 Advantages

a) The water chemistry of the Unit can be maintained within specified limits and the system can be kept free of corrosion products, deposits, dissolved and suspended impurities. In nuclear power plants (BWRs) this will go a long way in keeping the inventory of activation products low;
b) Since make-up joins return condensate before CPU, some contamination of DM

water in storage tanks or deterioration in DM water quality due to leaks from DM plants can be taken care of by CPP without having to reject the DM water;

c) Provision of CPP will reduce the need of blow down of boiler, thus resulting in saving of DM water;

d) Since by providing CPP, Unit can be taken on full load quickly from cold start-up, so there will be time saving as well as DM water saving as condensate dumping will be considerably reduced;

e) Points (c) and (d) will also obviously result in fuel saving;

f) In case of condenser leaks not being major, Unit can be still kept on load without adversely affecting the water chemistry of the Unit and without having to dump condensate or boiler water; and

g) Attemperation spray water quality will be uniformly maintained.

10.2 Limitation

Suitable precautions should be taken to avoid the following:

a) In case of deep bed condensate polishing system, immediately after regeneration, the bed may leak-out some residual regenerant chemicals thus contaminating feed water quality;

b) Any disintegration of resin in CPP will directly cause contamination of feed water by disintegrated resin;

c) Since CPU is installed in the main steam water circuit, it may result in operational disturbances such as excess pressure drop across CPU; and

d) Pressure and temperature of influent to CPU may not be always compatible with the design conditions. This may impair the resin characteristics.

ANNEX A

(*Foreword*)

COMMITTEE COMPOSITION

Water Quality for Industrial Purpose Sectional Committee, CHD 13

Organization(s)	*Representative(s)*
Bhabha Atomic Research Centre, Mumbai	Shri K. P. Bhattacharyya **(*Chairperson*)**
Bhabha Atomic Research Centre, Mumbai	Shri Shivayyanamath S. Shri T. K. Dey (*Alternate*)
Bharat Heavy Electrical Limited, Thiruchirapali	Shri Shailendra Kumar K. Ananda Babu (*Alternate*)
CII-Triveni Water Institute	Shri Kapil K. Narula Dr Sipika Chauhan (*Alternate*)
Central Ground Water Board, Faridabad	Dr Neelam Nigam Shrimati Pooja Mehrotra (*Alternate*)
Central Leather Research Institute, Chennai	Dr C. Muralidharan Dr K. Sri Bala Kameswari (*Alternate*)
Central Pollution Control Board, New Delhi	Shri Nazimuddin Shri Vishal Gandhi (*Alternate*)
Central Pulp and Paper Research Institute, Sharanpur	Dr Nitin Endlay Dr Sanjay Tyagi (*Alternate*)
Central Salt and Marine Chemicals Research Institute, Bhavnagar	Dr Soumya Haldar Dr D. N. Srivastava (*Alternate*)
CECRI, Karaikudi	Dr S. Vasudevan Dr R. Malini (*Alternate*)
Chennai Petroleum Corporation Ltd, Chennai	Shri S. Shankar
Consumer education and Research Centre, Ahmedabad	Ms Anindita Mehta Ms Dolly Jain (*Alternate*)
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